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Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No.	P1866C/1053
First Inventor or Application Identifier	Fredenburg, T.
Title	System & Method For Using A Correspondence
Express Mail Label No.	EL117005384US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: **Box Patent Application, Washington, DC 20231**

1. [X] * Fee Transmittal Form *(e.g., PTO/SB/17)* *(Submit an original and a duplicate for fee processing)*
2. [X] Specification [*Total Pages* 33] *(preferred arrangement set forth below)*
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. [X] Drawing(s) *(35 U.S.C. 113)* [*Total Sheets* 7]
4. Oath or Declaration [*Total Pages*]
   a. [ ] Newly executed (original or copy)
   b. [X] Copy from a prior application (37 C.F.R. § 1.63(d)) *(for continuation/divisional with Box 17 completed)* ***[Note Box 5 below]***
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).
5. [X] Incorporation By Reference *(useable if Box 4b is checked)* The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered to be part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. [ ] Microfiche Computer Program *(Appendix)*
7. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. [ ] Computer Readable Copy
   b. [ ] Paper Copy (identical to computer copy)
   c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. [ ] Assignment Papers (cover sheet & document(s))
9. [ ] 37 C.F.R.§3.73(b) Statement *(when there is an assignee)* [X] Power of Attorney
10. [ ] English Translation Document *(if applicable)*
11. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
12. [X] Preliminary Amendment
13. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
14. [ ] * Small Entity Statement(s) *(PTO/SB/09-12)* [ ] Statement filed in prior application, Status still proper and desired
15. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. [ ] Other: .....

NOTE FOR ITEMS 1 & 14: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).

17. **If a CONTINUING APPLICATION,** *check appropriate box, and supply the requisite information below and in a preliminary amendment:*
    [X] Continuation [ ] Divisional [ ] Continuation-in-part (CIP) of prior application No: 08 / 665,404
    Prior application information: Examiner EDOUARD Group / Art Unit: 2741

18. CORRESPONDENCE ADDRESS

[ ] *Customer Number or Bar Code Label* *(Insert Customer No. or Attach bar code label here)* *or* [X] *Correspondence address below*

Name					
Address	CARR & FERRELL, LLP				
	2225 East Bayshore Road, Suite 200				
City	Palo Alto	*State*	California	*Zip Code*	94303
Country	USA	*Telephone*	650-812-3400	*Fax*	650-812-3444

Name (Print/Type)	Eppa Hite	*Registration No. (Attorney/Agent)*	30,266
Signature		*Date*	10/8/98

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FEE TRANSMITTAL

Patent fees are subject to annual revision on October 1. These are the fees effective October 1, 1997. Small Entity payments must be supported by a small entity statement, otherwise large entity fees must be paid. See Forms PTO/SB/09-12. See 37 C.F.R. §§ 1.27 and 1.28.

TOTAL AMOUNT OF PAYMENT ($) 790.00

Complete if Known	
Application Number	Unknown
Filing Date	Herewith
First Named Inventor	Fredenburg, T.
Examiner Name	Unknown
Group / Art Unit	Unknown
Attorney Docket No.	P1866C/1053

METHOD OF PAYMENT (check one)

1. [X] The Commissioner is hereby authorized to charge indicated fees and credit any over payments to:

Deposit Account Number: 06-0600

Deposit Account Name:

[X] Charge Any Additional Fee Required Under 37 C.F.R. §§ 1.16 and 1.17

[ ] Charge the Issue Fee Set in 37 C.F.R. § 1.18 at the Mailing of the Notice of Allowance

2. [X] **Payment Enclosed:** [X] Check [ ] Money Order [ ] Other

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	790	201	395	Utility filing fee	790.00
106	330	206	165	Design filing fee	
107	540	207	270	Plant filing fee	
108	790	208	395	Reissue filing fee	
114	150	214	75	Provisional filing fee	

SUBTOTAL (1) ($) 790.00

2. EXTRA CLAIM FEES

	Extra Claims		Fee from below	Fee Paid
Total Claims 20	-20** = 0	X		= 0
Independent Claims 3	- 3** = 0	X		= 0
Multiple Dependent				= 0

***or number previously paid, if greater; For Reissues, see below*

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	22	203	11	Claims in excess of 20
102	82	202	41	Independent claims in excess of 3
104	270	204	135	Multiple dependent claim, if not paid
109	82	209	41	** Reissue independent claims over original patent
110	22	210	11	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 790.00

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet.	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	400	216	200	Extension for reply within second month	
117	950	217	475	Extension for reply within third month	
118	1,510	218	755	Extension for reply within fourth month	
128	2,060	228	1,030	Extension for reply within fifth month	
119	310	219	155	Notice of Appeal	
120	310	220	155	Filing a brief in support of an appeal	
121	270	221	135	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,320	241	660	Petition to revive - unintentional	
142	1,320	242	660	Utility issue fee (or reissue)	
143	450	243	225	Design issue fee	
144	670	244	335	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	790	246	395	Filing a submission after final rejection (37 CFR 1.129(a))	
149	790	249	395	For each additional invention to be examined (37 CFR 1.129(b))	

Other fee (specify) _____

Other fee (specify) _____

* Reduced by Basic Filing Fee Paid

SUBTOTAL (3) ($) 0

SUBMITTED BY				Complete (if applicable)	
Typed or Printed Name	Eppa Hite			Reg. Number	30,266
Signature		Date	10/8/98	Deposit Account User ID	

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT:	Timothy Fredenburg
SERIAL NO.:	Unknown (Parent 08/665,404)
FILING DATE:	On Even Date Herewith
TITLE:	System and Method For Using a Correspondence Table to Compress A Pronunciation Guide
EXAMINER:	Unknown (Parent P. Edouard)
ART UNIT:	Unknown (Parent 2741)
ATTY. DKT. NO.:	P1866C/1053

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231, on

Dated: 10/8/98

J. Eppa Hite

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to the first Office Action, please amend the above-identified application as follows:

In the Specification:

On page 1, line 3, at the beginning of the text insert:

--This is a continuation of co-pending application serial number

08/665,404, filed on June 18, 1996.--

In the Claims:

Cancel claims 1 through 33.

34. (Amended) A computer data storage medium storing a correspondence table which enables compression of a pronunciation dictionary, the correspondence table comprising:

a plurality of correspondence sets, each correspondence set including

a correspondence text entry; [and]

a correspondence phoneme entry representing the pronunciation of the correspondence text entry;[,] and

a correspondence symbol identifying the correspondence set.

Add the following claims 35 through 53:

35. The computer data storage medium of claim 34 further storing a tuning function for optimizing said correspondence table.

36. The computer data storage medium of claim 35 wherein said tuning function eliminates redundant correspondence sets and low usage correspondence sets from said correspondence table.

37. The computer data storage medium of claim 34 wherein said correspondence table includes said correspondence sets for all practical combinations of said correspondence text entries and said correspondence phoneme entries for a given language.

38. The computer data storage medium of claim 34 further storing:

a grouping of a plurality of said correspondence sets.

39. The computer data storage medium of claim 38 wherein said correspondence phoneme entries of said grouping are similar to one another in pronunciation.

40. A system for storing a pronunciation guide comprising:

a correspondence table for storing pronunciation data; and

a tuning function for optimizing said correspondence table.

41. The system of claim 40 wherein said correspondence table comprises at least one correspondence set.

42. The system of claim 41 wherein said tuning function eliminates redundant correspondence sets from said correspondence table.

43. The system of claim 42 further comprising:

a correspondence symbol corresponding to said text entry and to said phonetic entry for identifying said correspondence set.

44. The system of claim 42 wherein said correspondence table includes said correspondence sets for all practical combinations of said correspondence text entries and said phonetic entries for a given language.

45. The system of claim 42 further comprising:

a grouping of a plurality of said correspondence sets.

46. The system of claim 45 wherein said phonetic entries of said grouping are similar to one another in pronunciation.

47. The system of claim 41 wherein said tuning function eliminates low usage correspondence sets from said correspondence table.

48. The system of claim 41 wherein said at least one correspondence set comprises:

a correspondence text entry; and

a phonetic entry corresponding to said correspondence text entry.

49. The system of claim 48 wherein said phonetic entry is a phoneme, an allophone, or a syllable.

50. A method of storing a pronunciation guide, comprising the steps of:

inputting a correspondence set into a correspondence table; and

inputting into said correspondence table a correspondence symbol corresponding to said correspondence set.

51. The method of claim 50 further comprising the steps of:

optimizing said correspondence table; and

grouping a plurality of said correspondence sets.

52. The method of claim 51 wherein said step of optimizing further comprises the steps of:

eliminating redundant correspondence sets from said correspondence table; and

adding productive correspondence sets to said correspondence table.

53. The method of claim 50 wherein said step of inputting a correspondence set further comprises the steps of:

inputting a correspondence text entry into said correspondence table; and

inputting a phonetic entry corresponding to said correspondence text entry into said correspondence table.

REMARKS

The Office Action mailed February 20, 1998 (paper #5), in parent application 08/665,404 allowed claims 1-33. This preliminary amendment cancels claims 1-33, amends claim 34, and adds nineteen new claims 35-53. Claims 34-53 are now pending in this continuing Application. No new matter is being added. In view of the following remarks, Applicant respectfully requests reconsideration of the rejections and further examination of the continuing Application as amended.

Rejection under 35 U.S.C. § 102(b)

The Examiner rejected claim 34 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 4,779,080 by Coughlin, et al., *Electronic Information Display Systems* (hereinafter Coughlin).

In paragraph 4, page 3 of the Office Action, the Examiner stated that "Coughlin et al teach[es] a computer data storage medium storing a correspondence table . . . the correspondence table comprising: a plurality of correspondence sets, each correspondence set including . . . a correspondence phoneme entry representing the pronunciation of the correspondence text entry and a correspondence symbol identifying the correspondence set (his address data[])]". Applicant respectfully traverses. As new claims 35-53 are similar in scope to claim 34, no new search should be required and the following arguments anticipate similar rejections to claims 35-53.

Claim 34 (as amended) recites "a correspondence phoneme entry representing the pronunciation of the correspondence text entry . . . ." This limitation is supported in the Specification on page 10, lines 25-26 as follows: "a phoneme entry expressing at least one phonetic sound." Further, the Specification reflects that "although the invention has been described using phonemes, other alternative means for *representing pronunciation of text* are possible . . ." (page 22, lines 8-10, emphasis added).

In contrast, Coughlin teaches a dictionary "contained in [a] compact disc . . . for each of the text words that make up [a] dictionary. . . . For each text word, the set of data comprises . . . a sound portion *giving an audible pronunciation.*" (Col. 5 lines 22-26, emphasis added). In addition, Coughlin teaches an area "for selecting a sound pronunciation of the text word." (Col. 6, lines 40-41). Thus, Coughlin includes an actual audio pronunciation (or recording) of the text word when selected for playback by the system user. (Col. 5, lines 12-14). Coughlin does NOT teach a means for "representing the pronunciation of the correspondence text entry" as does the present invention. In addition, Coughlin does not disclose or teach the working of the sound portion.

A phoneme, or phonetic entry, is a guide to pronunciation and not the actual audio recording of the text. A phoneme is an abstract representation used in a phonetic system of a language that corresponds to a similar speech sound which is perceived to be a single distinctive sound of a basic speech unit in the language. For example, in English, the text "au" may be represented by

the phoneme "OW." The phoneme represents the sound that is made by a speaker when pronouncing the text, not the actual sound of the text. Coughlin does not teach a "correspondence phoneme entry representing the pronunciation of the correspondence text" of the correspondence table; nor does Coughlin teach, in any manner, the use of phonemes. On the contrary, Coughlin, finding a pronunciation guide to be inadequate, teaches away from the use of a phonetic guide. (Table, Col. 5, lines 12-4). Coughlin further states that a "pronunciation guide is not usually very helpful to the typical reader." (Col. 4, lines 43-44). Therefore, Coughlin does not teach a pronunciation guide and, thus, does not anticipate the present invention.

Furthermore, claim 34 (as amended) recites "a correspondence table . . . comprising: a plurality of correspondence sets, each correspondence set including: a correspondence text entry; a correspondence phoneme entry representing the pronunciation of the correspondence text entry; and a correspondence symbol identifying the correspondence set." This limitation is supported in the Specification on page 6, lines 11-15 as follows: "[c]orrespondence table 240 lists phoneme entries and text entries . . . . A text entry, a phoneme entry and a symbol together form a correspondence set, and a plurality of correspondence sets forms correspondence table 240." In addition, the present invention teaches that: "[c]orrespondence table 240 preferably includes correspondence sets for most practical combinations of correspondence text and phonemes in a given language." (page 6, lines 18-20).

Coughlin does NOT teach a correspondence table that includes the correspondence text and phoneme entries that "enable compression of a pronunciation dictionary." Furthermore, Coughlin teaches away from the use of a correspondence table. (Col. 4, lines 41-45). Therefore, Coughlin does not teach a correspondence table of text entries and phoneme entries and, thus, does not anticipate the present invention.

Claim 34 is also distinguishable over Coughlin where it recites "a correspondence table which enables compression of a pronunciation dictionary." This limitation is supported in the Specification on page 6, lines 23-26 as follows: "a tuning function 260 facilitates eliminating the less useful correspondence sets from, and adding more useful correspondence sets to, correspondence table 240." Further, "tuning function 260 . . . [is used] to compress at least a portion of pronunciation dictionary 210 . . .." (page 11, lines 4-6). In contrast, Coughlin does NOT teach or disclose, in any manner, the compression or optimization of a pronunciation guide.

Finally, claim 34 recites "a correspondence symbol identifying the correspondence set." This limitation is supported in the Specification on page 6, lines 11-17 as follows: "[e]ach correspondence set includes an identifier, referred to as a correspondence symbol, which may be simply the address of the set in correspondence table 240." The present invention uses the correspondence symbol to identify the phoneme for a given text entry. (page 7, lines 12-15).

Coughlin, in contrast, discloses "address data [which gives] the address where the set of data for each text word is located in the compact disc (CD ROM)." (Col. 5, lines 34-36). Thus, the address data is the address of the dictionary entry, not an identifier to a correspondence set entry as in the present invention. Therefore, Coughlin's address data does not anticipate the correspondence symbol of the present invention.

In view of the above remarks, Applicant respectfully contends that the rejection of claim 34 (and, by extension, claims 35-53) on all of the grounds set forth is fully traversed and overcome, and should be withdrawn, and that the continuing Application is in condition for allowance.

Respectfully submitted,
Timothy J. Fredenburg

Dated: 10/8/98 by: _____

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SYSTEM AND METHOD FOR USING A CORRESPONDENCE TABLE TO COMPRESS A PRONUNCIATION GUIDE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to data compression, and more particularly to a system and method using correspondence techniques to compress a pronunciation guide.

2. Description of the Background Art

Computer Random Access Memory (RAM) and disk space are becoming more available and affordable in desktop computer systems. A typical desktop computer system currently provides on the order of sixteen megabytes of RAM and one gigabyte of hard disk memory. This increasing availability allows programmers the freedom to create application programs and data files which occupy several megabytes of computer memory. However, minimizing the size of data files remains important for optimizing system performance and use of memory resources.

To minimize storage requirements, programmers compress large data files. One type of large file is a pronunciation dictionary, which includes dictionary words for a language such as American English and dictionary phonemes (phonetic sounds) representing the pronunciation of each of the dictionary words. A typical uncompressed pronunciation dictionary occupies up to about ten megabytes of memory.

Information such as a pronunciation dictionary can be compressed using certain symbols to replace redundant data. For

example, a typical compression technique assigns symbols to represent particular patterns of redundant data such as multiple zeros or ones. Multiple compression techniques may be performed successively to eliminate more redundancies and compress data further. Accordingly, a pronunciation dictionary may be compressed to around thirty percent or less of its original size.

Previous techniques for compressing pronunciation dictionaries do not take into account redundancies inherent in dictionary words and dictionary phonemes. Therefore, as an addition to other techniques for compressing a pronunciation dictionary, it is desirable to have a system and method for taking advantage of redundancies in pronunciation.

SUMMARY OF THE INVENTION

The present invention overcomes limitations and deficiencies of previous systems by providing a new system and method for compressing a pronunciation guide such as a pronunciation dictionary. The system substitutes a single symbol for some text and its pronunciation, and includes a central processing unit (CPU) and memory. The memory stores a compression system including parsing routines, a correspondence table, a matching system, a decoder table and a decoder system. The parsing routines extract a dictionary entry, which comprises a dictionary word and corresponding dictionary phonemes representing the pronunciation of the dictionary word, from an uncompressed pronunciation dictionary also stored in the memory. The correspondence table is made up of correspondence sets, each of which has a text entry, a phoneme entry representing the pronunciation of the text entry, and

a set-identifying symbol (i.e., a number). The matching system attempts to find all correspondence sets that match text and phoneme combinations of the dictionary entry.

If matches are found, then the matching engine selects the best matches and adds the representative correspondence symbol set to a compressed pronunciation dictionary. If a match is not found, then the matching system considers characters silent and/or phonemes unmatched, and assigns special symbols to be added to the compressed pronunciation dictionary. The matching system adds decoder code sets to a decoder table for translating the special symbols back to characters or phonemes.

The decoder system uses the compressed pronunciation dictionary and decoder code sets to generate corresponding phonemes for selected text. These phonemes can be used in processes such as speech recognition, speech synthesis, language translation, foreign language learning, spell checking, etc.

The present invention provides a method for compressing a pronunciation dictionary. The method creates a correspondence table comprised of correspondence sets, determines which correspondence sets match a dictionary word and its corresponding dictionary phonemes, and adds the correspondence symbols as compressed data entries to a compressed pronunciation dictionary. The invention also provides a method for using the compressed dictionary and decoder code sets to generate phonemes from input text.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a computer system including a compression system in accordance with the present invention;

FIG. 2 is a block diagram showing dictionary compressing components of the FIG. 1 compression system used to construct a compressed pronunciation dictionary;

FIG. 3 is a text-phoneme correspondence table for American English;

FIG. 4 is a block diagram showing components of the FIG. 1 compression system used in application of the compressed dictionary;

FIG. 5 is a flowchart illustrating the preferred method for compressing a pronunciation dictionary and using the compressed pronunciation dictionary for decoding selected text;

FIG. 6 is a flowchart further illustrating steps of the preferred method for compressing an entry from a pronunciation dictionary; and

FIG. 7 is an example phoneme set for American English.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 is a block diagram of a computer system 100 including a compression system 180 in accordance with the present invention. Computer system 100 is preferably based on a computer such as a Power Macintosh manufactured by Apple Computer, Inc. of Cupertino, California. Computer system 100 includes a Central Processing Unit (CPU) 110, an input device 120 such as a keyboard and mouse or scanner, and an output device 130 such as a Cathode Ray Tube (CRT) or audio speaker, a Random Access Memory (RAM)

150, a data storage (hard disk) 160, an operating system 170 and a compression system 180, each coupled to signal bus 140.

Operating system 170 is a program that controls processing by CPU 110, and is typically stored in data storage 160 and loaded into RAM 150 during computer system initialization. CPU 110 has access to RAM 150 for storing intermediate results and miscellaneous data.

Compression system 180 includes a dictionary compressing program 215 for compressing a pronunciation dictionary, and a decoder system program 420 for subsequently processing text and using the compressed pronunciation dictionary to retrieve phonemes representing the pronunciation of the text. Compression system 180 is also typically stored in data storage 160 and loaded into RAM 150 prior to execution by CPU 110.

FIG. 2 is a block diagram illustrating dictionary compressing program 215 of compression system 180, used with a pronunciation dictionary 210 to construct a compressed pronunciation dictionary 270. Pronunciation dictionary 210 is preferably a conventional compilation of dictionary words and of corresponding dictionary phonemes in a specified format expressing proper pronunciation of the dictionary words in, for example, American English. Suitable pronunciation dictionaries include the Oxford-American® Dictionary or the Random House® Dictionary. FIG. 7 illustrates an example phoneme list 700 for American English. List 700 includes thirty-eight phonemes and an example word which uses each phoneme. For example, the phoneme "AE" provides the sound made by the letter "a" as in the word "bat." Other phonemes or sound-representative symbols can alternatively be used.

Dictionary compressing program 215 includes parsing routines 220, a data buffer 230, a correspondence table 240, a matching system 250 and a tuning function 260. Parsing routines 220 extract a dictionary entry, which includes a dictionary word and at least one dictionary phoneme representing the pronunciation of the word, from pronunciation dictionary 210. For the example word "enough", the extracted dictionary entry includes the dictionary word "enough" and the corresponding phonemes "IH n UX f". Parsing routines 220 store the extracted dictionary entry in data buffer 230, which may be a portion of RAM 150 (FIG. 1).

Correspondence table 240 lists phoneme entries and text entries, for example, as shown for American English in FIG. 3. A text entry, a phoneme entry and a symbol together form a correspondence set, and a plurality of correspondence sets forms correspondence table 240. Each correspondence set includes an identifier, referred to as a correspondence symbol, which may be simply the address of the set in correspondence table 240.

Correspondence table 240 preferably includes correspondence sets for most practical combinations of correspondence text and phonemes in a given language. A correspondence table 240 which included every conceivable correspondence set would be inefficient because increasing the number of code sets degrades compression by subsequent compression techniques. Therefore, a tuning function 260 facilitates eliminating the less useful correspondence sets from, and adding more useful correspondence sets to, correspondence table 240. The utility or productivity of a correspondence set is determined by the number of dictionary entries it helps to compress. A pronunciation dictionary may be compressed a first time, and the

compressed dictionary examined to determine if any correspondence sets are used less than, say, five times. If so, the less used and thus unproductive correspondence sets can be eliminated or modified. Further, since phonemes typically have corresponding text, cases where a phoneme does not match any text may indicate a need to add a correspondence set.

Matching system 250 is a program which reads the extracted dictionary entry from buffer 230, retrieves correspondence sets from correspondence table 240, and compares the dictionary entry with the correspondence sets. More particularly, matching system 250 attempts to match the correspondence sets with combinations of phonemes and characters from the dictionary entry. If matches are made, matching system 250 assigns the correspondence symbol associated with the "best" matching correspondence set as a compressed data entry, as described below with reference to FIG. 6. If a match cannot be made for a particular dictionary character or phoneme, matching system 250 assigns, as compressed data entries, special symbols to represent silent characters or unmatched phonemes. The one or more compressed data entries representing an entire dictionary entry forms a "symbol set." The symbol sets for an entire pronunciation dictionary collectively form the "compressed pronunciation dictionary" 270.

Matching system 250 further generates decoder code sets for de-compressing compressed pronunciation dictionary 270, and adds the code sets to a "decoder table" 280. Each decoder code set includes a decoder text entry, a corresponding decoder phoneme entry, and a decoder set-identifying symbol equivalent to a correspondence symbol of correspondence table 240. Decoder table

280 is like correspondence table 240 except that decoder table 280 also includes decoder sets for the silent text characters and the unmatched phonemes. The decoder sets are described in more detail with reference to FIGs. 4 and 5.

FIG. 3 shows an example correspondence table 240 for American English. The first column specifies correspondence phoneme entries, the second column specifies correspondence text entries, and the third column specifies correspondence symbols. A correspondence text entry specifies text characters such as "e" or "ou," and is accompanied by typically only one phonetic sound. A correspondence phoneme entry, such as "IH," is expressed in the format used by pronunciation dictionary 210, for representing the phonetic sound of each correspondence text entry. Since some text entries produce multiple sounds, a phoneme entry may represent multiple sounds such as "y UH." Further, there may be correspondence entries which have multiple text characters and multiple phonemes, like "y UW→ieu."

The correspondence sets may be organized into groups of rows of like phonemes. Grouping rows based on phonemes facilitates comparison with dictionary combinations if creating table 240 by hand. In the first row of table 240, correspondence phoneme "AE" represents one of the possible pronunciations of correspondence text entry "ai", and this correspondence set is represented by the symbol "(1)". In the second row, the same correspondence phoneme "AE" represents one of the possible pronunciations of a different correspondence text entry, "a", and this correspondence set is represented by the symbol "(2)". In the third row, correspondence

phoneme "EY" represents another pronunciation of the same correspondence text entry "ai" in the first row, and this correspondence set is represented by symbol "(3)". These three rows illustrate how the same text entry may have different pronunciations, and different text entries may have the same pronunciation.

Correspondence table 240 may be generated manually, i.e. by typing the table into a computer file, or generated electronically, i.e. by computer analysis of productive phoneme-text combinations. It will be appreciated that each language, such as American English or French, would use a different correspondence table 240.

FIG. 4 is a block diagram illustrating the decoder system program 420 of compression system 180, and its input and output data. Selected input text 410 may be stored in data storage 160 and loaded into RAM 150 for examination. Decoder system program 420 receives a word from selected input text 410.

Decoder system 420 uses the decoder table 280 codes to translate symbol sets of compressed pronunciation dictionary 270 in searching for the compressed dictionary word whose text matches the received word, and then in producing phonemes for the received word. If the dictionary compressing method compressed pronunciation dictionary 210 entries in the original alphabetical order of the dictionary words, then the symbol sets are entered in the same alphabetical order in compressed pronunciation dictionary 270. Thus, decoder system 420 could approximate the location of the dictionary word which matches the input text word. Another embodiment of the dictionary compressing method provides an index

to compressed pronunciation dictionary 270. Further, any technique for searching a compressed file, such as a hashing function, may be used.

Upon matching a compressed dictionary word to the input text word, decoder system 420 uses the decoder table 280 codes to retrieve dictionary phonemes 430 from the matching symbol set. Alternatively, as it searches the compressed dictionary and converts symbol sets to find a dictionary word which matches the received text, decoder system 420 may also convert the symbol sets to produce phonemes at the same time.

For example, decoder system 420 receives the word "enough" from selected text 410. Decoder system 420 uses decoder table 280 to decode symbol sets from compressed pronunciation dictionary 270 until decoding a symbol set to match the dictionary word "enough". Upon finding a match, decoder system 420 uses decoder table 280 to translate the symbol set into the output data phonemes "IH n UX f" representing the pronunciation of the received text.

FIG. 5 is a flowchart illustrating a method 500 for compressing pronunciation dictionary 210 and for using the compressed dictionary to generate representative phonemes from selected input text 410. Method 500 begins in step 510 by creating a correspondence table 240 for a given language. Creating correspondence table 240 comprises the step of inputting a number of correspondence sets, each of which includes a phoneme entry expressing at least one phonetic sound and a text entry which indicates the phonetic sound or sounds, and inputting a correspondence set identifying symbol. Step 510 preferably includes

inputting a correspondence set for each of the various text representations of all of the phonemes used in pronunciation dictionary 210.

The step 510 preferably further includes tuning function 260 (FIG. 2) using the current version of correspondence table 240 to compress at least a portion of pronunciation dictionary 210 for determining which correspondence sets are unproductive and what other correspondence sets may be valuable if added. Tuning function 260 may be re-applied to optimize correspondence table 240, thereby enabling matching system 250 to more effectively compress pronunciation dictionary 210 and enabling compressed pronunciation dictionary 270 to be further compressed by subsequent compression techniques.

Program 215 in step 520 uses the optimized correspondence table 240 to compress pronunciation dictionary 210. More particularly, parsing routines 220 extract a dictionary entry including a dictionary word and corresponding dictionary phonemes from pronunciation dictionary 210, and store the dictionary entry in data buffer 230.

Matching system 250 selects a first phoneme from the dictionary entry, and retrieves all correspondence sets from correspondence table 240 which start with the selected dictionary phoneme to determine if a match can be made. Multiple dictionary characters which together constitute a correspondence text entry in correspondence table 240 are "related." Divisions between related dictionary characters are typically harder to determine than divisions between dictionary phonemes. Also, there are fewer dictionary phonemes without corresponding dictionary characters

(e.g., as in abbreviations such as "Mrs." or "etc.") than there are "silent" dictionary characters without phonemes. Therefore, matching system 250 preferably selects a dictionary phoneme, and attempts to match correspondence sets based on the dictionary phoneme.

Matching system 250 compares the correspondence sets retrieved from correspondence table 240 with the dictionary entry to determine if any matches can be made. If only one match is made, matching system 250 selects the correspondence symbol associated with the matching correspondence set as the compressed data entry for compressed pronunciation dictionary 270. If more than one match can be made, matching system 250 selects as the compressed data entry for compressed pronunciation dictionary 270 the symbol for the correspondence set corresponding to the best match. If no match can be made, matching system 250 generates special symbols to represent "silent" characters, or conversely generates special symbols to represent phonemes unmatched to dictionary text. Generation of special symbols is described in greater detail with reference to FIG. 6. If a special symbol is generated, a decoder code set representing the association of the special symbol to the silent character or alternatively to the unmatched phoneme is added to decoder table 280 for subsequently decoding the special symbol.

Matching system 250 then selects the next unprocessed phoneme, and repeats step 520 until the compressed data entries have been generated for the entire dictionary entry. Examples of this process are described with reference to Examples 1-3. After all the pronunciation dictionary 210 entries have been compressed, the

symbol set, which possibly includes special symbols, is added to compressed pronunciation dictionary 270. It will be appreciated that step 510 and step 520 are typically performed by a product developer.

Decoder system 420 in step 530 uses compressed pronunciation dictionary 270 and decoder table 280 to generate phonemes for selected text 410. Decoder system 420 receives a selected word from text 410, and then uses decoder table 280 to decode symbol sets from compressed pronunciation dictionary 270 until one of the decoded dictionary words matches the first input word. Decoder system 420 next uses decoder table 280 to retrieve the dictionary phonemes from the matching symbol set, and then method 500 ends for the first input word. Step 530 repeats for subsequently received words. It will be appreciated that step 530 is typically performed by a customer.

FIG. 6 is a flowchart illustrating a preferred method 600 for compressing an entry from pronunciation dictionary 210. Method 600 is repeated for every word in the dictionary to accomplish FIG. 5 step 520. Method 600 begins in step 605 by matching system 250 reading a dictionary entry, which comprises a dictionary word and a dictionary phoneme entry representing the pronunciation of the dictionary word, from buffer 230. Matching system 250 in step 610 determines whether any dictionary characters or dictionary phonemes remain unprocessed in the dictionary entry. If not, method 600 ends. Otherwise, matching system 250 in step 620 determines whether both a dictionary character and a dictionary phoneme remain.

If both remain, matching system 250 in step 630 searches correspondence table 240 for all correspondence sets that match dictionary phoneme-character combinations of the remaining portions of the dictionary entry. More particularly, selecting the next currently-unmatched phoneme, matching system 250 retrieves all correspondence sets which begin with the selected dictionary phoneme. Matching system 250 then compares these correspondence sets against the unmatched portions of the dictionary entry.

If matching system 250 in step 640 finds at least one match, then matching system 250 in step 650 selects the best match, assigns and stores symbols for any pending silent dictionary characters, and stores the correspondence symbol for the selected matching correspondence set. Method 600 then returns to step 610.

To select the best match, matching system 250 first selects from the matching sets as the tentative choice the correspondence set having the most phonemes. If there is more than one set having the most phonemes, then matching system 250 selects as the tentative choice the set that has the most phonemes and the most text characters. If there are more than one of these sets, matching system 250 just selects the first of them. The tentative choice is the best match unless matching system 250 determines one of the other sets satisfies selected criteria, suggesting that it is a better choice. The criteria include:

(1) the other correspondence set is shorter than the current tentative choice, i.e., it has fewer phonemes or has the same number of phonemes and fewer text characters;

(2) at least one unprocessed dictionary phoneme would remain in the dictionary entry after the non-tentative set is applied; and

(3) there is a correspondence set that matches the next unprocessed dictionary phonemes and dictionary characters that would remain if the non-tentative set were to be applied.

If another set meets the above criteria, it becomes the tentative choice. The process repeats until all other sets have been tested. Method 600 then returns to step 610.

If in step 640 no matches are found, matching system 250 in step 685 determines whether a threshold number of dictionary characters are currently assumed silent. If not, matching system 250 in step 690 considers the next dictionary character as silent, and returns to step 610. If in step 685 a set threshold number of silent characters are pending, matching system 250 in step 695 assigns and stores a special symbol for the current phoneme and considers pending silent dictionary characters as no longer silent, i.e. re-labels the pending silent characters as unprocessed. Method 600 then returns to step 610.

If in step 620 matching system 250 determines that there are not both a dictionary character and a phoneme remaining in the dictionary entry, then matching system 250 in step 660 determines whether it is characters or phonemes that remain. If characters remain, matching system 250 in step 670 assigns and stores special symbols for all pending silent and all remaining dictionary characters. If only phonemes remain, system 250 proceeds to step 695 and continues as explained above.

Example 1: "IH n UX f" and "enough"

Matching system 250 retrieves the dictionary word "enough" and the dictionary phonemes "IH n UX f" from data buffer 230. Matching system 250 then selects the first dictionary phoneme "IH," retrieves from exemplary table 240 (FIG. 3) all correspondence sets which begin with the selected phoneme (IH→a, IH→e, IH→i, IH→o, IH→u, IH→y), and determines if any of the correspondence sets match.

```
IH n UX f          enough
^                  ^
```

Matching system 250 finds only one match (IH→e) and accordingly "remembers," i.e. stores in memory, the symbol "(43)" representing the match.

Matching system 250 then selects the next unprocessed phoneme "n" and retrieves the correspondence sets (ny→gn, n→en, n→gn, n→kn, n→nn, n→n).

```
IH n UX f          e nough
  ^                  ^
```

Matching system 250 finds only match (n→n), and remembers the symbol "(161)" representing the only match.

Matching system 250 selects the third phoneme "UX" and retrieves the correspondence sets (UXr→r, UX→a, UX→eu, UX→e, UX→i, UX→ou, UX→o, UX→u, UX→y).

```
IH n UX f          en ough
    ^                ^
```

Matching system 250 finds two matches (UX→o and UX→ou), and selects the better match. Since UX→ou has more text characters matching system 250 selects it as the tentative best match. Matching

system 250 applies the three-criteria test as described with reference to FIG. 6 to confirm the best match assumption. The other set UX→o has fewer text characters, and a phoneme remains after it is applied. However, a match cannot be made with the next currently unmatched phoneme "f" and remaining text characters "ugh." Thus, matching system 250 selects UX→ou as the best match, and accordingly remembers the correspondence symbol "(89)."

Matching system 250 selects the next unprocessed phoneme "f" and retrieves the correspondence sets (f→ff, f→f, f→gh, f→ph).

IH n UX f enou gh
^ ^

Matching system 250 finds only one match (f→gh) and thus remembers "123" as representing the match. Accordingly, matching system 250 stores the symbol set "43 161 89 123" in compressed pronunciation dictionary 170 as the compressed data entry representing the dictionary word "enough" and its dictionary phonemes "IH n UX f".

Example 2: "AE n s UX r" and "answer"

Matching system 250 retrieves the dictionary word "answer" and the dictionary phonemes "AE n s UX r". In a manner similar to that described in Example 1, matching system 250 matches the dictionary combination AE→a and represents it by correspondence symbol "2," matches the dictionary combination n→n and represents it by symbol "161" and matches the dictionary combination s→s and represents it by symbol "173." At this time, matching system 250 selects dictionary phoneme "UX" and retrieves the correspondence

sets (UXr→r, UX→a, UX→eu, UX→e, UX→i, UX→ou, UX→o, UX→u, UX→y).

AE n s UX r ans wer
^ ^

Matching system 250 finds no match. Thus, matching system 250 assumes that "w" is silent.

With the "w" silent, matching system 250 examines the correspondence sets with the remaining unprocessed dictionary entry.

AE n s UX r answ er
^ ^

Matching system 250 finds a match (UX→e), and thus assigns and stores a special symbol such as "221" to represent the silent dictionary character "w" and remembers the symbol "(87)." Further, matching system 250 adds the decoder code set, for example "221 w ø" wherein the empty set represents no phoneme, to decoder table 280.

Lastly, matching system 250 selects the dictionary phoneme "r" and retrieves the correspondence sets (r→rr, r→er, rr→r, r→r).

AE n s UX r answe r
^ ^

Matching system 250 finds only one match (r→r), and selects the symbol "(155)." Matching system 250 adds "2 161 173 221 87 155" to compressed pronunciation dictionary 270 as a symbol set representing the word "answer" and the phonemes "AE n s UX r."

Example 3: "r IH D AX m" and "rhythm"

Matching system 250 retrieves the dictionary word "rhythm" and the dictionary phonemes "r IH D AX m," selects the first dictionary phoneme "r" and retrieves the correspondence sets (r→rr, r→er, rr→r, r→r).

```
r IH D AX m        rhythm
^                  ^
```

Matching system 250 finds only one match (r→r), and remembers the symbol "169."

Matching system 250 selects the next unprocessed phoneme "IH" and retrieves the correspondence sets (IH→a, IH→e, IH→i, IH→o, IH→u, IH→y).

```
r IH D AX m        r hythm
  ^                  ^
```

Matching system 250 finds no matches. Accordingly, matching system 250 assumes the "h" is silent. With the "h" silent, matching system 250 then examines the remaining portions of the dictionary entry.

```
r IH D AX m        rh ythm
  ^                  ^
```

Matching system 250 finds a match (IH→y), assigns a special symbol such as "222" for silent "h" and remembers the symbol "47."

Matching system 250 then selects the next unprocessed phoneme "D" and retrieves only correspondence set (D→th), since in this example matching system 250 is case sensitive.

```
r IH D AX m        rhy thm
    ^                ^
```

Matching system 250 finds a match and remembers the symbol "120."

Matching system 250 then selects the next unprocessed phoneme "AX" and retrieves the correspondence sets (AXk→c, AXl→l, AXm→m, AX→a, AX→e, AX→ia, AX→i, AX→o, AX→u, AX→y, AX→').

r IH D AX m rhyth m
^ ^

Matching system 250 finds only one match (AXm→m), and remembers symbol "(16)." Since no other characters exist, matching system 250 adds "169 222 47 120 16" to compressed pronunciation dictionary 270 as a symbol set representing the dictionary word "rhythm" and the corresponding phonemes "r IH D AX m."

If for example the correspondence set AXm→m was not included in correspondence table 240, matching system 250 would find no match. Accordingly, matching system 250 would assume the text character "m" is silent. Since only characters would remain, matching system 250 would emit a special symbol such as "223" for current phoneme "AX" and would consider the text character "m" is no longer silent. Matching system 250 would then retrieve the correspondence sets (m→lm, m→mm, m→m) for phoneme "m", would find the only match m→m, and would remember the symbol "155." Since no other characters would exist, matching system 250 would add "169 222 47 120 223 155" to compressed pronunciation dictionary 270 as a symbol set representing the dictionary word "rhythm" and the corresponding phonemes "r IH D AX m."

The present invention advantageously provides a system and method for compressing a pronunciation dictionary. This is

especially useful, for example, as a precursor to other compression techniques. The system and method take advantage of the natural redundancy between dictionary text and dictionary phonemes. Since compression system 180 substitutes symbols for sets of dictionary words and phonemes, memory required to store the information is reduced by approximately one-third to one-half.

For example, each character in a word may be represented by five bits (since there are twenty-six letters in the English alphabet), and each phoneme may be represented by six bits (since there are about thirty-nine phonemes for American English as illustrated in FIG. 7). Further, dictionary words and the set of phonemes for each dictionary word are divided by a terminator character. The word "enough" requires seven characters (including the terminator character) and thus occupies thirty-five bits. The corresponding phoneme set "IH n UX f" requires five characters (including the terminator character), and thus occupies thirty bits. Thus, the total memory for storing this dictionary entry is sixty-five bits.

A decoder table 280, as shown in FIG. 3, has about 220 correspondence sets and 220 correspondence symbols. Accordingly, eight bits are needed to represent a correspondence symbol. As illustrated in the first example, the four symbols "(43)", "(161)", "(89)" and "(123)" represent the word "enough" and phonemes "IH n UX f". Thus, five symbols (including the terminator character) are needed and occupy forty bits. Forty bits provides a thirty-eight percent savings over the uncompressed sixty-five bits.

The foregoing description of the preferred embodiments of the invention is by way of example only, and other variations are

provided by the present invention. For example, components of this invention may be implemented using a programmed general purpose digital computer, using application specific integrated circuits, or using a network of interconnected conventional components and circuits. Further, although the invention has been described with reference to a dictionary, any guide having text and phonemes can be compressed using the system and method of the present invention. Still further, although the invention has been described using phonemes, other alternative means for representing pronunciation of text are possible, such as allophones, syllables or symbols generated by an earlier compression system. The embodiments described herein are presented for purposes of illustration and are not intended to be exhaustive or limiting. Many variations and modifications are possible in light of the foregoing teaching. The system is limited only by the following claims.

WHAT IS CLAIMED IS:

1. A system for compressing a pronunciation guide which includes a plurality of guide entries, each entry having a guide word and at least one associated phoneme representing the pronunciation of the word, the system comprising:

memory storing

(1) a correspondence table which includes a plurality of correspondence sets, each set having

(i) a text entry,

(ii) a phoneme entry representing a pronunciation of the text entry, and

(iii) a symbol identifying the correspondence set; and

(2) a matching system for comparing a selected guide word and the associated phonemes with correspondence sets, and storing correspondence symbols which represent matching correspondence sets as a compressed pronunciation guide entry in the memory; and

a processing unit coupled to the memory for controlling the operations of the matching system.

2. The system of claim 1 wherein the correspondence table includes correspondence sets for productive combinations of phonemes and text in a particular language.

3. The system of claim 1 wherein the correspondence symbols are numbers, each representing the position of the respective correspondence set in the correspondence table.

4. The system of claim 1 wherein the memory further stores a tuning function which enables deletion of unproductive correspondence sets from the correspondence table.

5. The system of claim 1 wherein the matching system compares various correspondence sets, and if several matches are made selects the best match.

6. The system of claim 1 wherein the matching system generates a special symbol representing a silent character, and stores the special symbol as part of a compressed pronunciation guide entry in the memory.

7. The system of claim 1 wherein the matching system generates a special symbol representing a phoneme without any corresponding characters, and stores the special symbol as part of a compressed pronunciation guide entry in the memory.

8. The system of claim 1 wherein the matching system generates a decoder table comprising decoder code sets for use in subsequently de-compressing compressed pronunciation guide entries.

9. The system of claim 8 wherein the decoder code sets replicate a portion of the correspondence table.

10. The system of claim 8 wherein the decoder code sets include symbols representing silent text.

11. The system of claim 8 wherein the decoder code sets include symbols representing phonemes without corresponding characters.

12. The system of claim 1 wherein the matching system selects correspondence sets from the correspondence table for comparison with characters and phonemes from the guide entry.

13. The system of claim 1 wherein the pronunciation guide includes a pronunciation dictionary.

14. A system for using a compressed pronunciation guide and decoder table to decode selected text, comprising:

memory storing

(1) a compressed pronunciation guide having a plurality of symbol sets, each symbol set representing a guide word and at least one corresponding guide phoneme representing the pronunciation of the guide word,

(2) a decoder table having a plurality of decoder code sets for translating symbol sets, each decoder code set including a decoder text entry, a decoder phoneme entry and a decoder symbol representing the decoder code set;

(3) a decoder system for using the decoder table to translate symbol sets to find a guide word which matches the selected text, and upon finding a match using the decoder table

to retrieve the decoder phonemes from the matching symbol set; and

a processor coupled to the memory for controlling the operations of the decoder system.

15. The system of claim 14 wherein the decoder code sets include symbols representing silent text.

16. The system of claim 14 wherein the decoder code sets include symbols representing phonemes without corresponding characters.

17. A computer-based method for compressing a pronunciation guide which includes a plurality of guide entries, each entry having a guide word and at least one associated guide phoneme representing the pronunciation of the guide word, comprising the steps of:

providing a computer memory;

storing in a first portion of the computer memory a correspondence table which includes a plurality of correspondence sets, each correspondence set including a correspondence text entry, a correspondence phoneme entry representing a pronunciation of the correspondence text entry and a unique correspondence symbol identifying the correspondence set;

receiving a guide word and at least one guide phoneme representing the pronunciation of the guide word;

comparing the guide word and guide phonemes with correspondence sets; and

storing the correspondence symbols representing matching correspondence sets as compressed pronunciation guide entries in a second portion of the computer memory.

18. The method of claim 17 wherein the correspondence table includes correspondence sets for productive combinations of phonemes and text in a particular language.

19. The method of claim 17 wherein the correspondence symbol is a number representing the position of the correspondence set in the correspondence table.

20. The method of claim 17 further comprising, after the step of storing in a first portion and before the step of receiving, the step of deleting unproductive correspondence sets from the correspondence table.

21. The method of claim 17 wherein the step of comparing further comprises:

selecting a next currently-unmatched guide phoneme from the guide entry;

retrieving all correspondence sets from the correspondence table which begin with the selected guide phoneme; and

comparing the retrieved correspondence sets with the remaining portions of the guide entry.

22. The method of claim 21 wherein the step of comparing further comprises examining several correspondence sets, and if multiple matches are made selecting the best match.

23. The method of claim 22 wherein the step of comparing further comprises, if a match is not made, generating a special symbol which represents a silent guide character, and storing the special symbol in the memory as part of a compressed pronunciation guide entry.

24. The method of claim 22 wherein the step of comparing further comprises, if a match is not made, generating a special symbol which represents a phoneme without any corresponding guide characters, and storing the special symbol in the memory as part of a compressed pronunciation guide entry.

25. The method of claim 17 and further comprising the step of generating a decoder table including decoder code sets for de-compressing the compressed pronunciation guide entries.

26. The method of claim 25 wherein the decoder code sets replicate a portion of the correspondence table.

27. The method of claim 25 wherein the decoder code sets include symbols representing silent text.

28. The method of claim 25 wherein the decoder code sets include symbols representing phonemes without corresponding guide characters.

29. The method of claim 17 further comprising, after the step of storing in a second portion, the step of using the compressed pronunciation guide to generate phonemes representing the selected text.

30. A computer-based method for using a compressed pronunciation guide and a decoder table to retrieve phonemes for selected text, comprising the steps of:

providing computer memory;

storing in a first portion of the computer memory a compressed pronunciation guide which includes a plurality of symbol sets, each symbol set representing a guide word and at least one guide phoneme representing the pronunciation of the guide word;

storing in a second portion of the computer memory a decoder table which includes a plurality of decoder sets, each decoder set having a decoder text entry, a decoder phoneme entry representing the pronunciation of the decoder text entry, and a unique decoder set identifying symbol;

receiving selected text;

using the decoder table to decode a symbol set in the pronunciation guide to produce a guide word;

comparing the selected text with the guide word to determine if they match; and

if a match is made, using the decoder table to retrieve the guide phonemes corresponding to a matching symbol set.

31. A computer storage medium storing a computer program for causing a computer to perform the steps of:

allocating computer memory;

storing in a first portion of the computer memory a compressed pronunciation guide which includes a plurality of symbol sets, each symbol set representing a guide word and guide phonemes representing the pronunciation of the guide word;

storing in a second portion of the computer memory a decoder table which includes a plurality of decoder sets, each decoder set having a decoder text entry, a decoder phoneme entry representing the pronunciation of the decoder text entry, and a unique decoder set identifying symbol;

receiving selected text;

using the decoder table to decode a symbol set in the pronunciation guide to produce a guide word;

comparing the selected text with the guide word to determine if they match; and

if a match is made, using the decoder table to retrieve the guide phonemes corresponding to a matching symbol set.

32. A computer storage medium storing a computer program for causing a computer to perform the steps of:

allocating computer memory;

storing in a first portion of the computer memory a correspondence table which includes a plurality of correspondence sets, each correspondence set including a correspondence text entry, a correspondence phoneme entry representing the pronunciation of

the correspondence text entry and a unique correspondence symbol identifying each correspondence set;

receiving a guide word and at least one guide phoneme representing the pronunciation of the guide word;

comparing the guide word and guide phonemes with correspondence sets; and

storing the correspondence symbols representing matching correspondence sets as compressed pronunciation guide entries, in a second portion of the computer memory.

33. A computer-based system for compressing a pronunciation guide, which includes a guide word and at least one guide phoneme representing the pronunciation of the guide word, comprising:

computer memory;

means for storing in a first portion of the computer memory a correspondence table which includes a plurality of correspondence sets, each correspondence set including a correspondence text entry, a correspondence phoneme entry representing the pronunciation of the correspondence text entry, and a unique correspondence symbol identifying the correspondence set;

means for receiving a guide word and at least one guide phoneme representing the pronunciation of the guide word;

means for comparing the guide word and guide phonemes with correspondence sets; and

means for storing the correspondence symbols representing matching correspondence sets as a compressed pronunciation guide entry in a second portion of the computer memory.

34. A computer data storage medium storing a correspondence table which enables compression of a pronunciation dictionary, the correspondence table comprising a plurality of correspondence sets, each correspondence set including a correspondence text entry and a correspondence phoneme entry representing the pronunciation of the correspondence text entry, and a correspondence symbol identifying the correspondence set.

SYSTEM AND METHOD FOR USING A CORRESPONDENCE TABLE TO COMPRESS A PRONUNCIATION GUIDE

ABSTRACT OF THE DISCLOSURE

Parsing routines extract from a conventional pronunciation dictionary an entry, which includes a dictionary word and dictionary phonemes representing the pronunciation of the dictionary word. A correspondence table is used to compress the pronunciation dictionary. The correspondence table includes correspondence sets for a particular language, each set having a correspondence text entry, a correspondence phoneme entry representing the pronunciation of the correspondence text entry and a unique correspondence set identifying symbol. A matching system compares a dictionary entry with the correspondence sets, and replaces the dictionary entry with the symbols representing the best matches. In the absence of a match, symbols representing silent text or unmatched phonemes can be used. The correspondence symbols representing the best matches provide compressed pronunciation dictionary entries. The matching system also generates decoder code sets for subsequently translating the symbol sets. A decoder system uses the decoder code sets for translating symbol sets in the compressed pronunciation dictionary to generate phonemes corresponding to selected text.

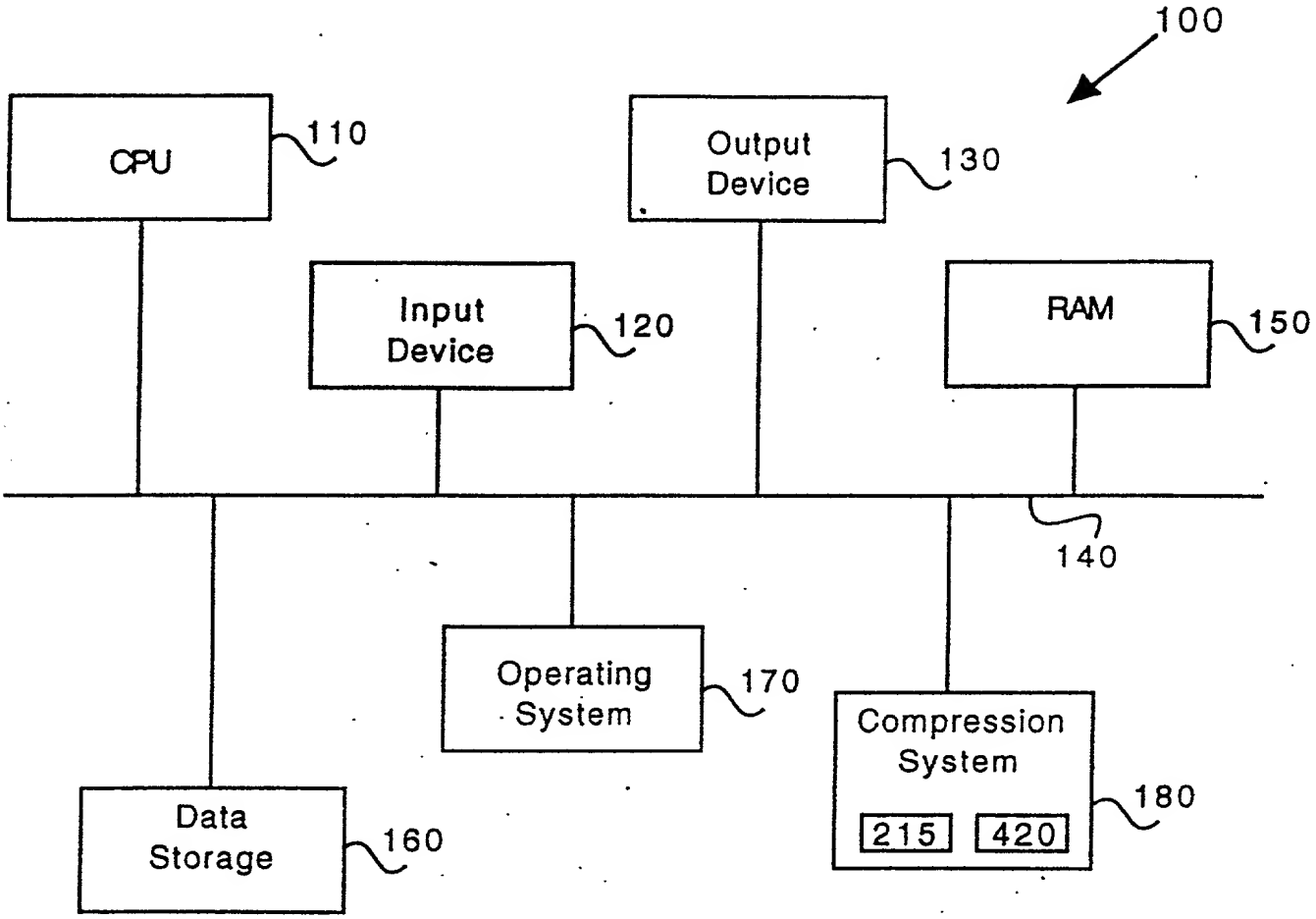
100
CPU
110
Output Device
130
Input Device
120
RAM
150
140
Operating System
170
Compression System
180
215
420
Data Storage
160

FIG. 1

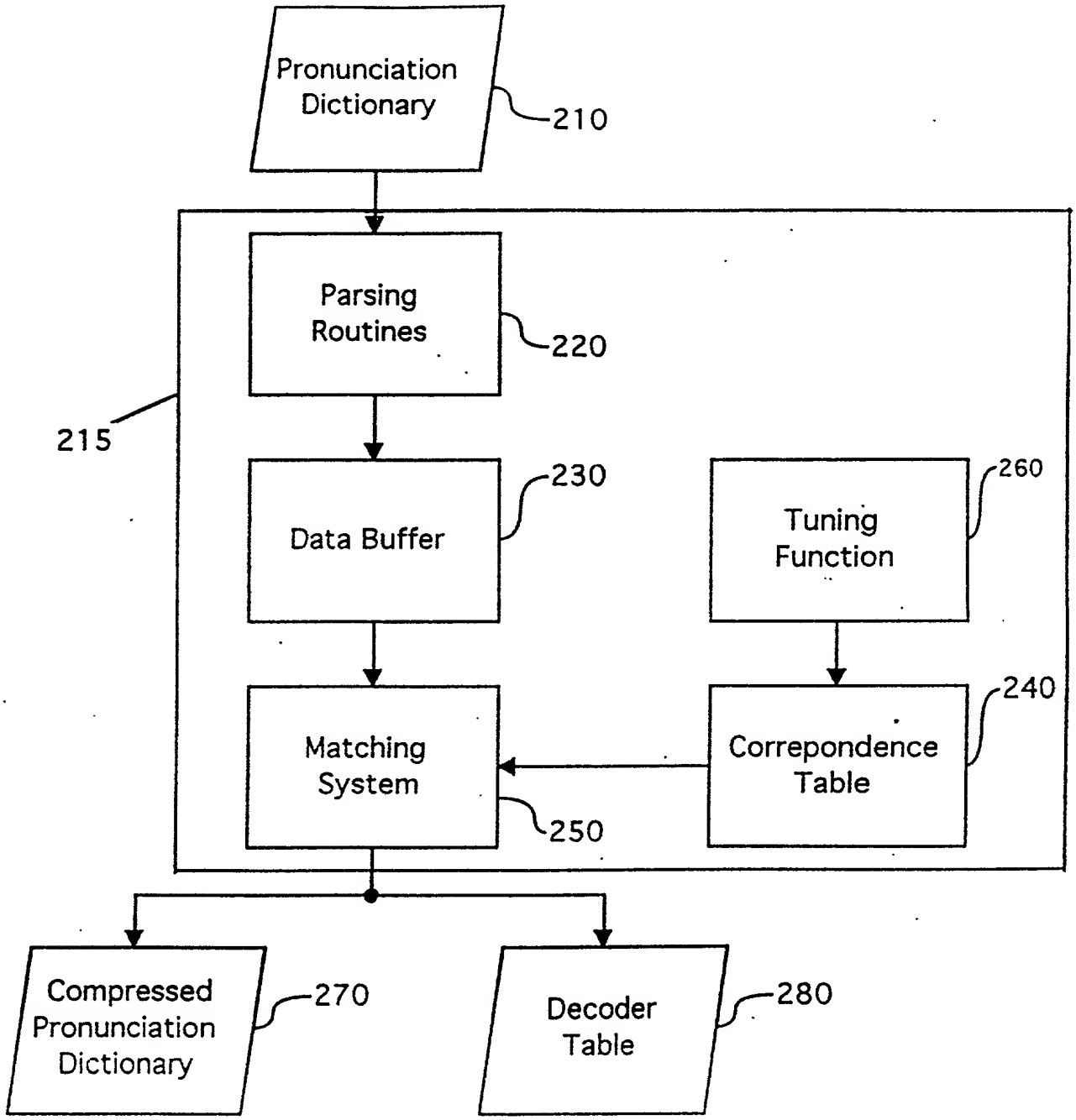
Pronunciation Dictionary
210
Parsing Routines
220
215
Data Buffer
230
Tuning Function
260
Matching System
250
Correpondence Table
240
Compressed Pronunciation Dictionary
270
Decoder Table
280

FIG. 2

FIG. 3: A Correspondence Table for American English

240

Phoneme(s)	Text Entry	Symbol
AE	ai	(1)
AE	a	(2)
EY	ai	(3)
EY	ae	(4)
EY	ay	(5)
EY	a	
EY	ey	
EY	e	
AO	au	
AO	a	(10)
AO	oa	
AO	ou	
AO	o	
AX k	c	
AX l	l	
AX m	m	
AX	a	
AX	e	
AX	ia	
AX	i	(20)
AX	o	
AX	u	
AX	y	
AX	'	
IY IX	u	
IY	ae	
IY	ea	
IY	ee	
IY	eo	
IY	ey	(30)
IY	e	
IY	ie	
IY	i	
IY	oe	
IY	y	
EH	ae	
EH	ai	
EH	a	
EH	ea	
EH	e	(40)
EH	u	
IH	a	
IH	e	
IH	i	
IH	o	
IH	u	
IH	y	
AY	a e	
AY	ai	
AY	a	(50)
AY	i	
AY	y	
IX l	le	
IX n	n'	
IX	ae	
IX	a	
IX	eou	
IX	ea	

Phoneme(s)	Text Entry	Symbol
IX	e	
IX	iou	(60)
IX	io	
IX	ia	
IX	i	
IX	ou	
IX	o	
IX	u	
IX	y	
IX	'	
AA	aa	
AA	a	(70)
AA	e	
AA	ow	
AA	o	
UW	ew	
UW	oo	
UW	ou	
UW	o	
UW	u	
UH l	le	
UH	e	(80)
UH	oo	
UH	o	
UH	u	
UX r	r	
UX	a	
UX	eu	
UX	e	
UX	i	
UX	ou	
UX	o	(90)
UX	u	
UX	y	
OW	au	
OW	a	
OW	ew	
OW	oa	
OW	ou	
OW	ow	
OW	o	
AW	ao	(100)
AW	au	
AW	a	
AW	ou	
AW	ow	
OY	aw	
OY	oi	
OY	oy	
b	bb	
b	b	
C	ch	(110)
C	c	
C	s	
C	tch	
C	t	
d	dd	

Phoneme(s)	Text Entry	Symbol
d	d	
d	ed	
d	tt	
d	t	
D	th	(120)
f	ff	
f	f	
f	gh	
f	ph	
g z	x	
g Z	x	
g	gg	
g	gh	
g	g	
h	h	(130)
h	j	
h	x	
J	dg	
J	dj	
J	d	
J	g	
J	j	
k w	cqu	
k s	x	
k S	x	(140)
k T	th	
k	cc	
k	ch	
k	ck	
k	c	
k	k	
k	lk	
k	qu	
k	q	
l	ll	(150)
l	l	
l	sl	
m	lm	
m	mm	
m	m	
n y	gn	
n	en	
n	gn	
n	kn	
n	nn	(160)
n	n	
N	ng	
N	n	
p	pp	
p	p	
r r	r	
r	er	
r	rr	
r	r	
s	c	(170)
s	sc	
s	ss	

Phoneme(s)	Text Entry	Symbol
s	s	
s	z	
S	c	
S	sh	
S	ss	
S	s	
S	t	
t s	z	(180)
t	d	
t	ed	
t	th	
t	tt	
t	t	
T	th	
v	f	
v	v	
w 1 AA	oi	
w 1 UX	o	(190)
w AA	oi	
w UX	o	
w	u	
w	w	
y 1 UH	u	
y 1 UW	u	
y 1 UW	ew	
y 1 UX	u	
y UH	u	
y UW	ew	(200)
y UW	ieu	
y UW	u	
y UX	u	
y IX	u	
y AX	a	
y AX	u	
y AA	o	
y	i	
y	j	
y	ll	(210)
y	y	
z	es	
z	s	
z	x	
z	z	
Z	g	
Z	j	
Z	ss	
Z	s	
Z	z	(220)

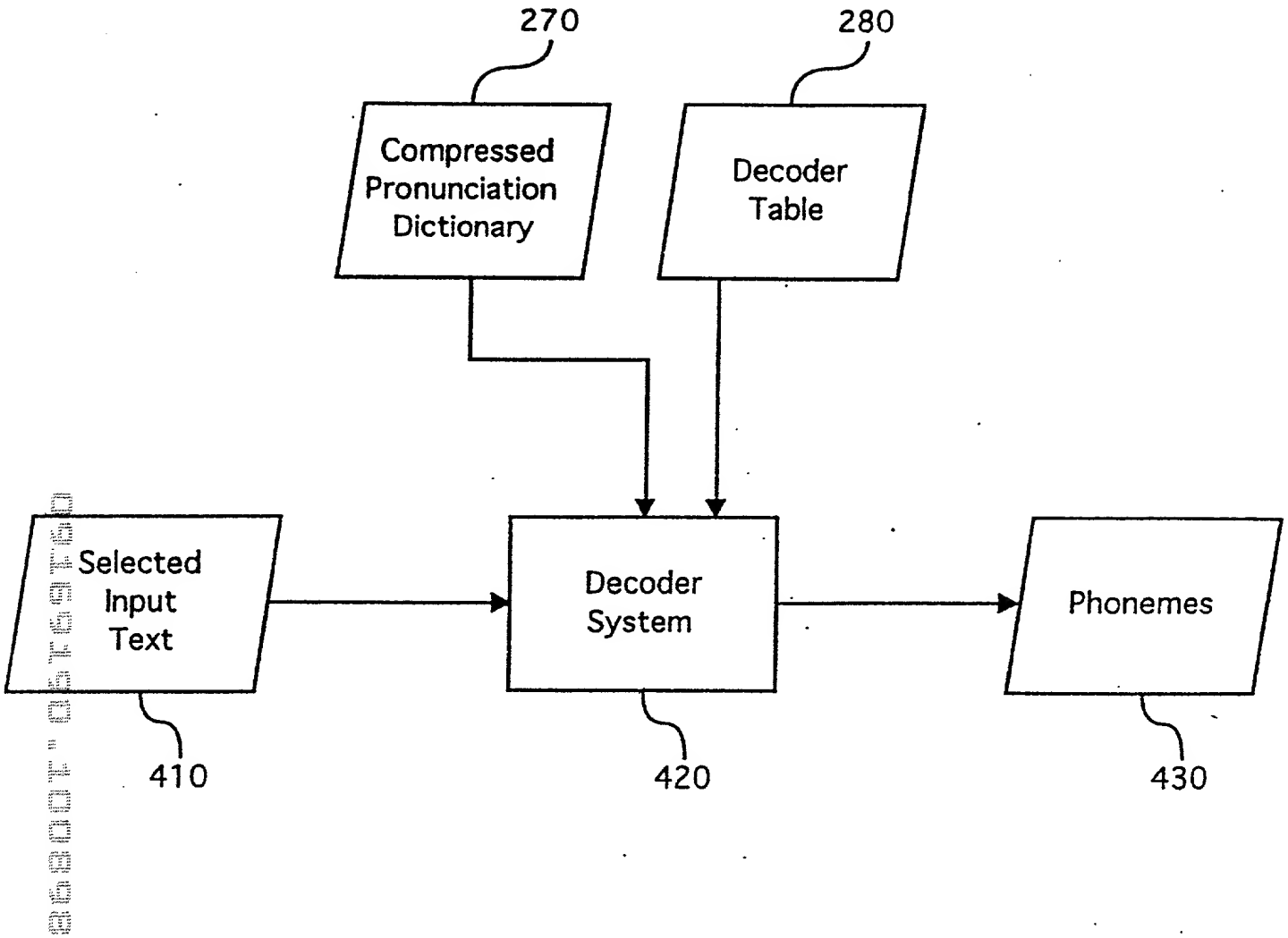
270
280
Compressed Pronunciation Dictionary
Decoder Table
Selected Input Text
Decoder System
Phonemes
410
420
430

FIG. 4

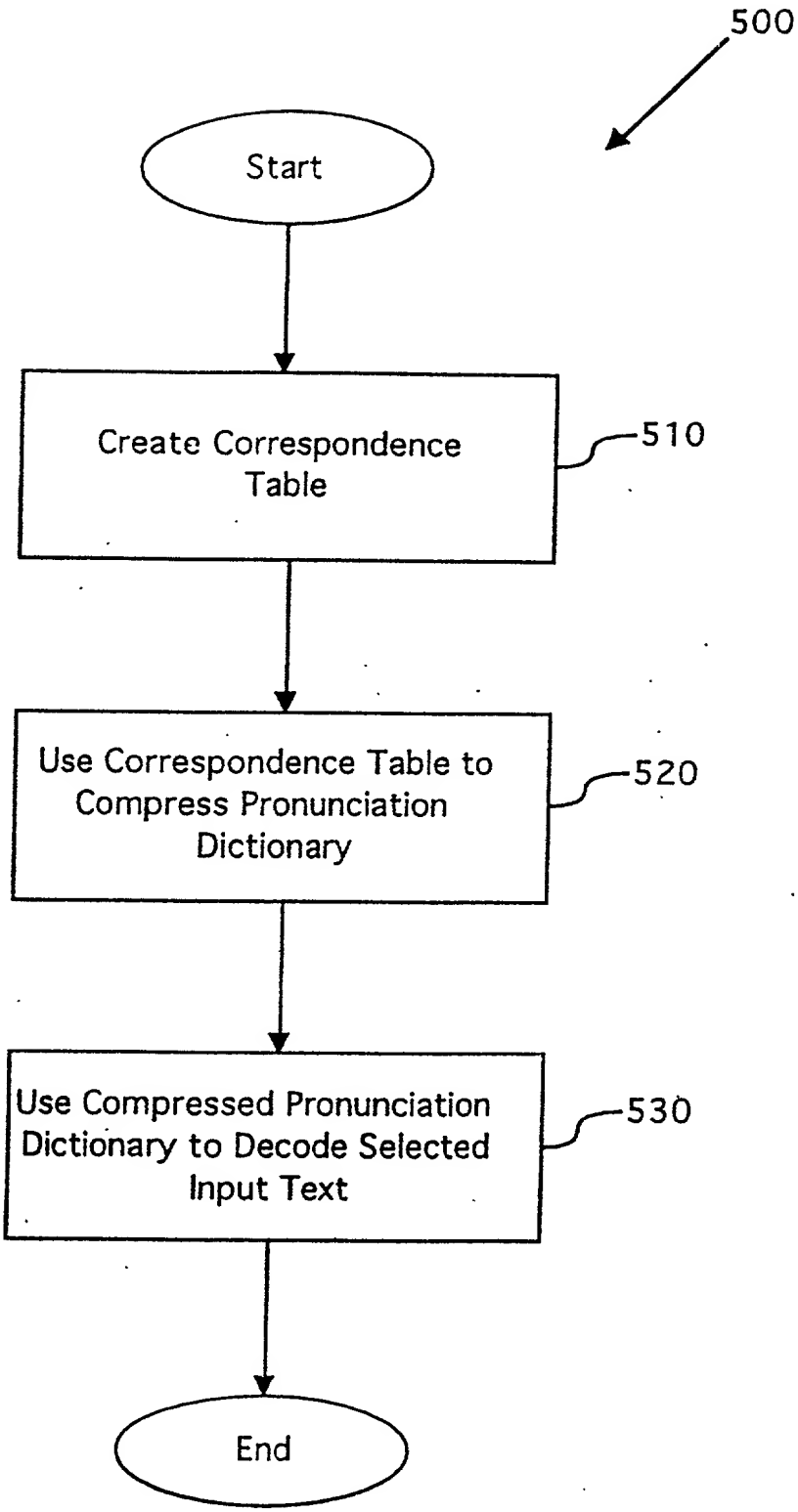
500
Start
Create Correspondence Table
510
Use Correspondence Table to Compress Pronunciation Dictionary
520
Use Compressed Pronunciation Dictionary to Decode Selected Input Text
530
End

FIG. 5

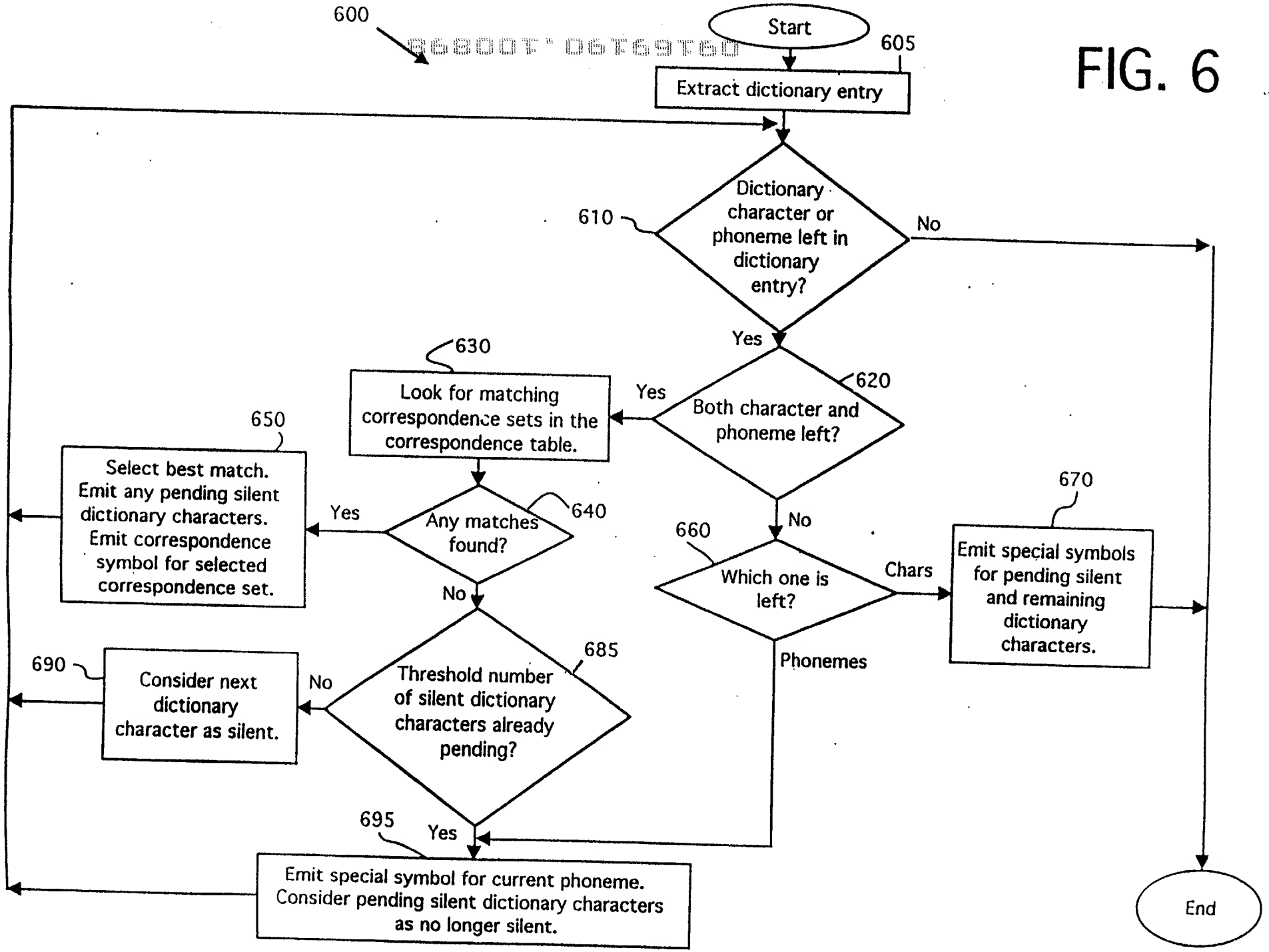
600
Start
605
Extract dictionary entry
610
Dictionary character or phoneme left in dictionary entry?
No
Yes
620
Both character and phoneme left?
Yes
630
Look for matching correspondence sets in the correspondence table.
650
Select best match. Emit any pending silent dictionary characters. Emit correspondence symbol for selected correspondence set.
Yes
640
Any matches found?
No
660
Which one is left?
Chars
670
Emit special symbols for pending silent and remaining dictionary characters.
Phonemes
685
Threshold number of silent dictionary characters already pending?
690
Consider next dictionary character as silent.
No
695
Yes
Emit special symbol for current phoneme. Consider pending silent dictionary characters as no longer silent.
End

FIG. 6

Phoneme Set for American English

700

Phoneme symbol	Example
AE	bat
EY	bait
AO	caught
AX	about
IY	beet
EH	bet
IH	bit
AY	bite
IX	roses
AA	cot
UW	boot
UH	book
OW	boat
AW	bout
OY	boy
b	bin
C	chin
d	din
D	them
f	fin
g	gain
h	hat
J	jump
k	kin
l	limb
m	mat
n	nat
N	lang
p	pin
r	ran
s	sin
t	tin
T	thin
v	van
w	wet
y	yet
z	zen
Z	measure

FIG. 7

Additionally, the symbol "1" is used to indicate primary stress.

PATENT CASE/DOCKET NO.: P1866

DECLARATION AND POWER OF ATTORNEY FOR UTILITY PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name,

I believe I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled

" System and Method for Using a Correspondence Table to Compress a Pronunciation Guide "

the specification of which

|X| is attached hereto.
|_| was filed on_____ as _____
Application Serial No._____
and was amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I do not know and do not believe that the same was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and said invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to this application.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119, of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, Section 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.) (Filing Date)	(Status) (patented, pending, abandoned)
(Application Serial No.) (Filing Date)	(Status) (patented, pending, abandoned)

I hereby appoint

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole inventor: **Timothy Fredenburg**

Inventor's signature _____ Dated: 6/12/96

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